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# CT-7000 S3

digital circuit breaker analyzer



**Vanguard Instruments**  
A DOBLE COMPANY





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## digital circuit breaker analyzer

### Product Overview

The CT-7000 S3 is Vanguard's fourth generation EHV circuit breaker analyzer. The CT-7000 S3 is available with 3 (part number 9021-UC) or 6 contact timing channels (part number 9100-UC). The CT-7000 S3 can fully analyze a circuit breaker's performance by measuring the main contact and resistor contact time, stroke, velocity, over-travel, bounce back and contact wipes. Both contact and motion analysis can be performed on all circuit breaker operations (OPEN, CLOSE, OPEN-CLOSE, CLOSE-OPEN, and OPEN-CLOSE-OPEN). The CT-7000 S3's timing window is selectable between 1 second, 10 seconds, and 20 seconds.

### ordering information

Part No.	Description
9021-UC	CT-7000 S3 with 3 contact channels, cables, and PC software
9100-UC	CT-7000 S3 with 6 contact channels, cables, and PC software
9021-DG	Dual ground option
9021-OT	On-line timing option
9021-BT	Bluetooth option
9021-SC	CT-7000 S3 shipping case
TP4-CS	TP4 thermal printer paper (24 rolls)

### Contact Timing Inputs

The CT-7000 S3's dry contact timing channels (up to 6 channels) are used to time the circuit breaker main contacts. Each main contact timing channel is capable of detecting the main contact and insertion resistor contact time. Timing results are displayed in milliseconds and cycles.

### Breaker Stroke and Velocity

Three dedicated digital travel transducer channels are available on the CT-7000 S3 for measuring circuit-breaker contact stroke, velocity, over-travel, and bounce back. With the use of the Vanguard digital travel transducers, neither calibration nor setting is required. Circuit breaker contact velocity is calculated based on contact's travel distance over a period of time. Special formulas to calculate velocity is also accommodated by the CT-7000 S3. A special feature is also available to "Slow-Close" test the circuit breaker and obtain a test result report.

### Resistor Type Transducer Input

The CT-7000 S3 offers 3 resistor type transducer input channels. These input channels are used to interface with any resistor-type transducers to monitor the circuit breaker motion. Transducer resistance ranges from 200 Ohms to 10K Ohms.

### Voltage Monitoring Channels

The CT-7000 S3 features three voltage monitoring input channels (V1, V2, and V3). The V1 voltage channel is dedicated to monitoring the substation DC supply or coil voltage (0-255 V, DC or peak AC). The nominal and minimum DC supply voltage levels are recorded and printed on the tabulated report. An analog waveform showing the DC power supply is plotted on the graphical report. The two digital voltage input channels, V2 and V3, are dedicated to monitoring voltage on/off status presence or absence of the circuit breaker auxiliary switches. Digital waveforms showing V2 and V3 activity are plotted on the graphical report. Three timing events of the V2 and V3 activities are recorded and printed on the tabulated report.

### OPEN/CLOSE Coil Current Monitoring

One built-in, hall-effect sensor records the OPEN/CLOSE coil current amplitude and waveform. The circuit breaker's coil current waveform, effectively, a coil performance "fingerprint" or "current profile", can be used as a diagnostic tool for analyzing the circuit breaker's performance.

### Breaker Initiate Features

A built-in solid-state initiate device is used to operate a breaker from the CT-7000 S3. Operational modes include OPEN, CLOSE, OPEN-CLOSE, CLOSE-OPEN, and OPEN-CLOSE-OPEN. Multiple operation like OPEN-CLOSE, CLOSE-OPEN, and OPEN-CLOSE-OPEN can be initiated by using a programmable delay time (in milliseconds) or by sensing a specific breaker contact condition. The circuit breaker coil current amplitudes and waveforms are recorded and can be printed on the thermal printer.

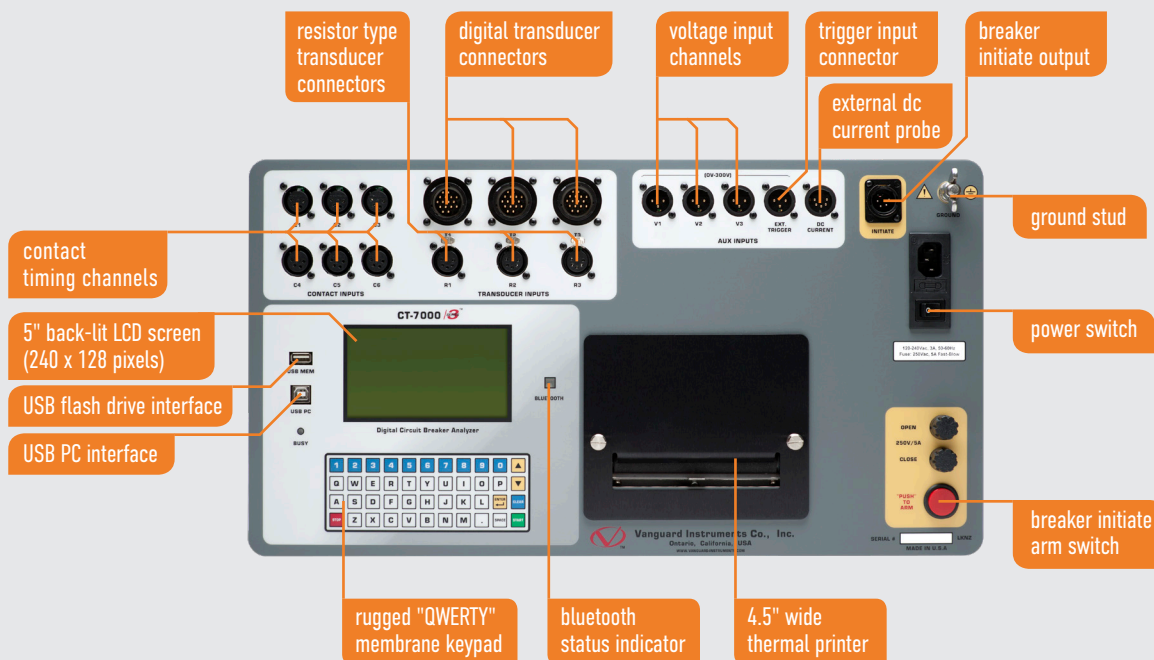
### Computer Interface

The CT-7000 S3 can be computer-controlled via the USB or optional Bluetooth interface. Windows-based Circuit Breaker Analysis Software is provided with each unit. Using this software, circuit breakers can be timed from the PC. Test records can be retrieved from the CT-7000 S3 and then stored on the PC for future analysis and report generation. Circuit breaker test plans can also be created on the PC and transferred to the CT-7000 S3. Additionally, test records can be automatically exported in Excel, PDF, and XML formats.

### Built-in Thermal Printer

The CT-7000 S3's built-in 4.5" wide thermal printer can print the breaker contact analysis results in both tabular and graphic formats.

# CT-7000 S3 Features



## User Interface

The CT-7000 S3 features a back-lit graphic LCD screen (240 x 128 pixels) that is viewable in direct sunlight and low-light levels. A rugged 44-key "QWERTY"-style membrane keypad is used to control the unit and input information.

## Diagnostic Capabilities

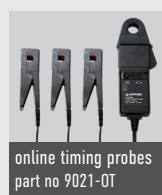
The CT-7000 S3 can perform diagnostics on its internal electronics. Diagnostics can be performed to verify contact cable connections and to test the travel transducer's electronics.

## Internal Test Record and Test Plan Storage

The CT-7000 S3 uses Flash memory to store up to 200 test records internally. Test records can be recalled and printed on the unit's built-in 4.5" wide thermal printer. Test records can also be transferred to a USB Flash drive or exported to a PC via the USB port or Bluetooth (optional) with the included Windows-based software.

Up to 100 circuit breaker test plans can be stored in the CT-7000 S3's Flash memory. A test plan is comprised of all circuit breaker performance specifications (contact time, stroke, velocity, etc.). When a test plan is used with a timing test, a Pass/Fail report is generated by comparing the actual performance with the specifications in the stored test plan. Test plans can be transferred to the CT-7000 S3 from a USB Flash drive, or from a PC via the USB port or Bluetooth (optional).

## Optional Features



### "On-line" Timing Mode

In addition to the conventional off-line timing mode, the CT-7000 S3 also offers an optional three-phase "on-line" timing mode. In this mode, the CT-7000 S3 captures the breaker's trip or close time, the trip/close coil current "fingerprint," and the battery supply voltage while the breaker is still in service. The trip/close time is derived from the time of trip, or close coil initiation, to the breaker's bushing current breaker-make as detected by a AC clamp-on current sensing probes. Trip/Close current waveforms are also captured by an external clamp-on DC current probe.

The "on-line" timing mode can detect a breaker's operating conditions with little or no down time. In this mode, the first trip operation time of the breaker is captured. If a breaker has been in service for a long period of time and sitting in close position, the first trip time of the breaker may be slow possibly due to a sticky mechanism. The "on-line" mode is very useful in such cases because traditional breaker timing may not detect this condition since several operations may have occurred before the first timing test is conducted.



### Dual Ground Testing Mode

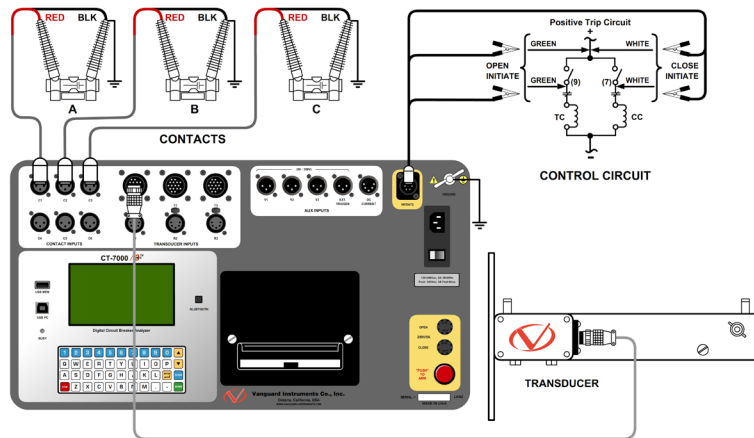
With the optional dual ground testing mode, the CT-7000 S3 can measure a CB contact time with ground being applied to both sides of the bushings. The clamp-on probe is connected to one side of the CB safety ground straps, and an AC signal is coupled to this strap. A sensor on the probe will detect a change in the induced AC signal when the CB contact is opened or closed.

### Bluetooth Interface

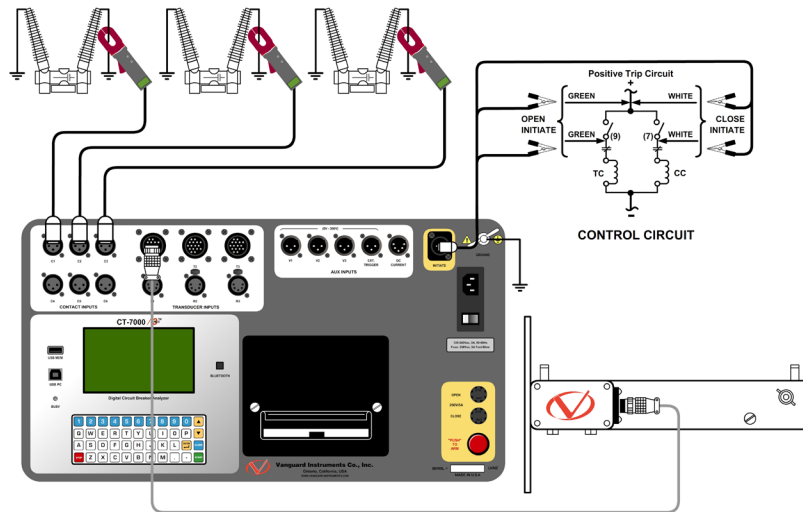
The optional Bluetooth interface can be used to wirelessly connect the CT-7000 S3 with a PC.



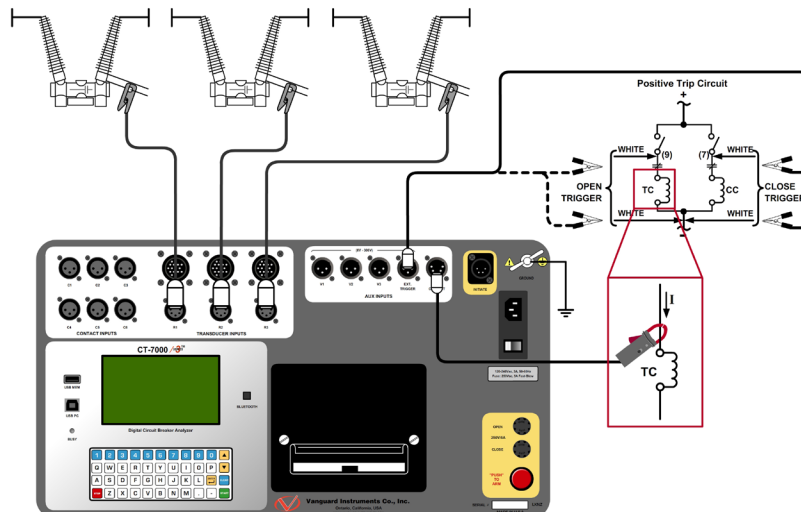
# CT-7000 S3 Connections



Typical CT-7000 S3 Connections
































Connections for Optional Dual Ground Testing Mode



Connections for Optional Online Timing Mode

# CT-7000 S3 technical specifications

 <b>physical specifications</b>	<b>Dimensions:</b> 21½"W x 8"H x 14" D (53 cm x 20 cm x 35 cm) <b>Weight:</b> 15 lbs. (6.8 Kg)	 <b>input power</b>	3 A, 100 – 240 Vac, 50/60 Hz
 <b>dry-contact inputs</b>	3 channels (9021-UC) or 6 channels (9100-UC). Each channel can detect the main contact and resistor contact time.	 <b>timing windows</b>	1 second, 10 seconds, or 20 seconds
 <b>timing resolutions</b>	±50 micro-seconds @ 1 sec. duration, ±500 micro-seconds @ 10 sec. duration, ±1.0 milliseconds @ 20 sec. duration		
 <b>timing accuracy</b>	0.05% of reading ±0.05 milli-seconds @ 1 second duration	 <b>dry-contact detection range</b>	<b>closed:</b> less than 20 ohms; <b>open:</b> greater than 5,000 ohms
 <b>resistor detection range</b>	50 – 5,000 ohms	 <b>trigger input voltage</b>	open/close: 24 – 300 V, dc or peak ac
 <b>dry contact input protection</b>	All contact inputs are grounded until test. Input channels are also protected against static discharge.	 <b>breaker operations</b>	initiate open, close, open-close, close-open, open-close-open
 <b>voltage sensing input range</b>	V1: analog input; 0 – 250 V dc or peak ac; sensitivity ±1 V; record and print voltage level V2 and V3: voltage presence/absence detector input; 24 – 255 V dc or peak ac; record and print 3 timing events		
 <b>breaker initiate capacity</b>	30 A, 250 V ac/dc max	 <b>resistor type transducer inputs</b>	3 channels, 200 ohms – 10 K ohms
 <b>digital travel transducer input</b>	3 digital travel transducer channels; linear range: 0.0 – 60.0 in (±0.01 in); rotary range: 0 – 360 degrees (±0.36 degrees)		
 <b>initiate current reading range</b>	one, non-contact, Hall-effect sensor, 0 – 20 amp range, dc to 5 KHz ac	 <b>contact travel point difference</b>	measures “slow-close” contact-point distances; results can be printed
 <b>display</b>	5" back-lit LCD screen (240 x 128 pixels); viewable in bright sunlight and low light levels	 <b>internal test record storage</b>	stores up to 200 test records and 100 test plans
 <b>printer</b>	built-in 4½" wide thermal printer that can print both graphic contact travel waveforms and tabulated test results	 <b>external data storage</b>	USB Flash drive interface for external storage of test records and test plans
 <b>pc software</b>	Windows®-based Circuit Breaker Analysis software (VCBA S2) included with purchase price. Software updates available at no additional charge	 <b>computer interfaces</b>	one USB port, optional Bluetooth interface
 <b>safety</b>	designed to meet UL 6101A-1 and CAN/CSA C22.2 No 1010.1-92 standards		
 <b>temperature</b>	<b>Operating:</b> -10°C to +50°C (+15°F to +122°F) <b>Storage:</b> -30°C to +70°C (-22°F to +158°F)	 <b>humidity</b>	90% RH @ 40°C (104°F) non-condensing
 <b>cables</b>	20' (6.1 m) contact leads, 30' (9.1 m) contact lead extensions, 20' (6.1 m) control and voltage cables, 25' (7.6 m) digital transducer cable, USB cable, power cord, ground cable		
 <b>options</b>	shipping cases (available for the CT-7000 S3 and travel transducers), on-line timing mode, dual ground testing mode, bluetooth interface	 <b>warranty</b>	one year on parts and labor

**NOTE :** the above specifications are valid at nominal voltage and ambient temperature of +25°C (+77°F). Specifications are subject to change without notice.

## Optional Testing Features

### on-line timing mode

<b>on-line current sensor</b>	three non-contact ac current sensors, range 0 – 100 A
<b>on-line dc current sensor</b>	one non-contact dc current sensor, range 0 – 20 A
<b>on-line timing accuracy</b>	±1 ms

### dual ground timing mode

<b>dual ground clamp-on probes</b>	three non-contact ac current sensors, range 0 – 100 A
<b>dual ground timing accuracy</b>	±1 ms

# CT-7000 S3 Desktop Printer Output

Desktop printout of tabulated test results



**Vanguard Instruments Company, Inc.**

Filename: 76072-052908-SHOT069.DAT

Company: DUKE ENERGY

Station: DAN RIVER 100 YARD

Circuit: 30075423 4

Model: SPS2

Date/Time: 01/30/15 11:36:25

Manufacturer: SIEMENS

S/N: 30075423 4

Operator: J THOMPSON

Test: OPEN

CONTACT (OPEN)

CHA	P/F	Time(ms)	Cycle	Bounce(ms)	Wipe(mm)
1	P	27.300	1.64	0.05	34.04
2	P	27.500	1.65	0.05	34.93
3	P	27.200	1.63	-0.05	33.53

Delta Time(ms): 0.300 (P/F) = F

CT Channel Analysis: 0.000 (ms)

Travel Analysis		T1	P/F
Stroke (mm)		109.22	P
Overtravel (mm)			
Velocity (m/s)		5.49	P
Overtravel (mm)		4.19	P
Bounce Back (mm)		2.16	P

Speed Analysis

AP1 CT

AP2 CT+10.000 ms

Initiator Current: 12.136 A

V1 Nominal: 0V

V1 Min: 0V

Shot Length: 1 SEC

Insertion Resistor: None

Delay: None

Trigger: Internal

Desktop printout of graphic test results

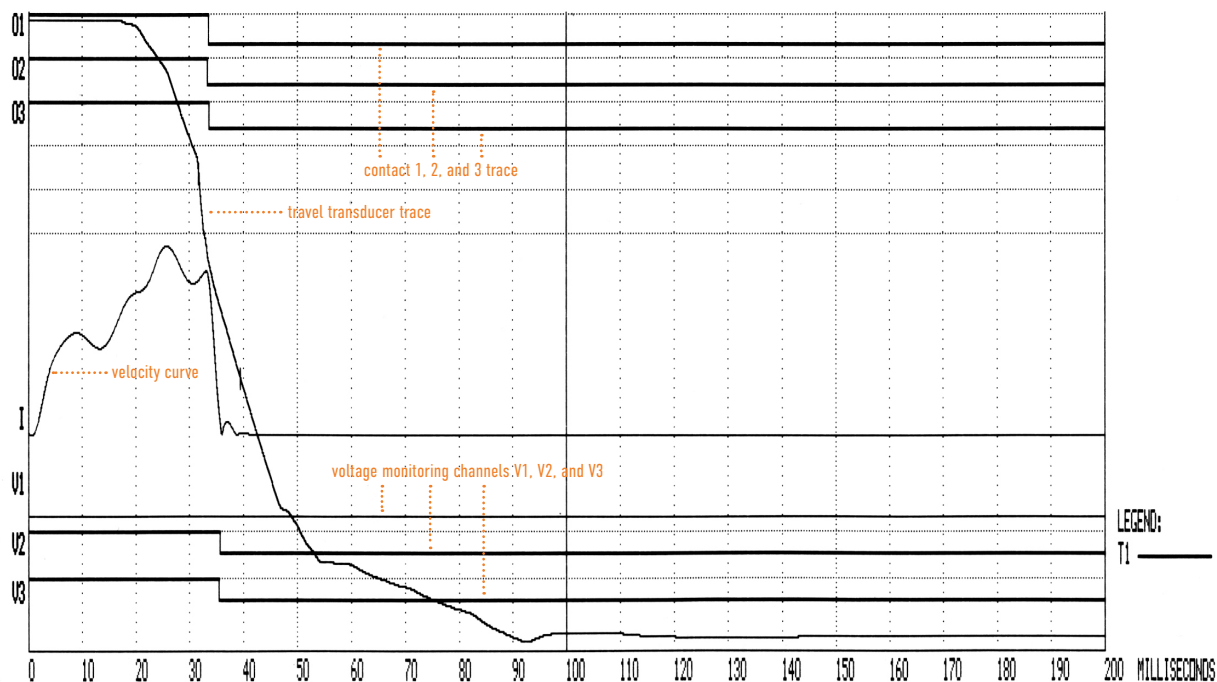


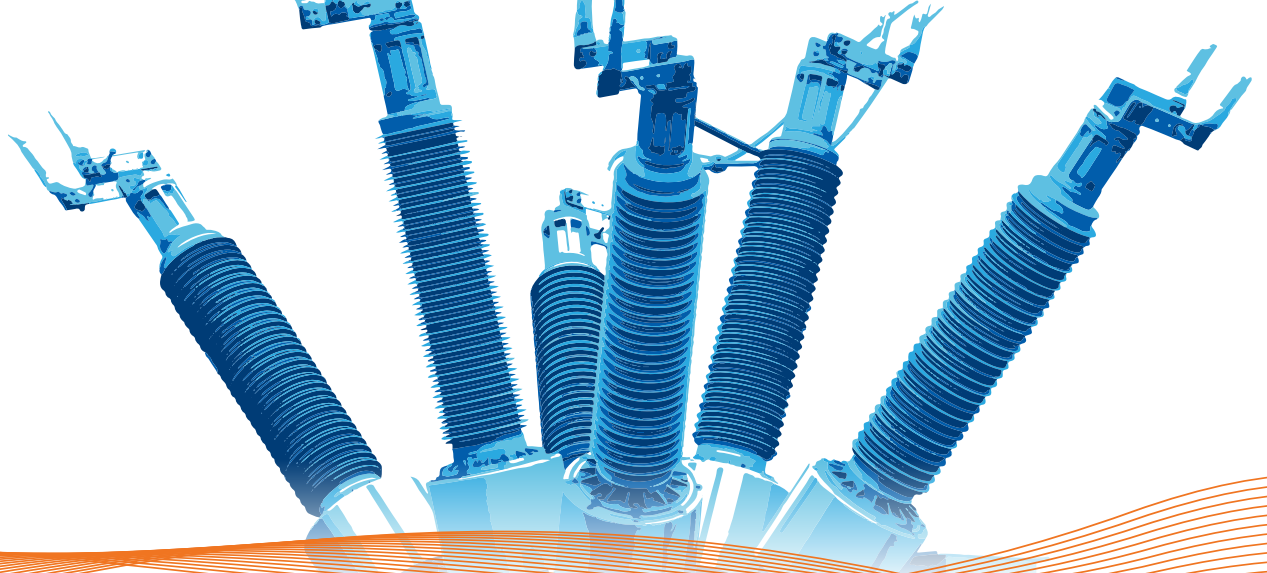
# CT-7000 S3 Thermal Printer Output

Thermal printout of tabulated test results

BREAKER TIMING RESULTS - 60 Hz				
SHOT NUMBER: 44				
DATE: 01/17/15 TIME: 14:41:02				
COMPANY: VANGUARD INSTRUMENTS				
STATION: STATION NUMBER 1				
CIRCUIT:				
MFR: ABB				
MODEL: 72PM31 12B				
S/N: 101797				
OPERATOR:				
TEST: OPEN				
CONTACT TIME				
CH	TIME	CYCLE	BOUNCE	WIPE
	<ms>		<ms>	<mm>
1	33.35	1.98	0.05	47.0
2	33.15	1.99	0.15	45.5
3	33.50	2.01	0.10	47.9
DELTA TIME <ms>: 0.35				
TRAVEL ANALYSIS T1				
STROKE mm 120.1				
SPEED M/S 5.21				
OVER-TRAVEL mm 1.1				
BOUNCE BACK mm 0.6				
SPEED ANALYSIS:				
POINT 1 = 30.0 mm				
POINT 2 = 70.1 mm				
U1 NOMINAL VOLTAGE = 0 VOLTS				
U1 MINIMUM VOLTAGE = 0 VOLTS				
U2/U3 TRANSITION TIMES				
U2 U3				
T1:	35.50 ms	35.30 ms		
T2:	N/A	N/A		
T3:	N/A	N/A		
INITIATOR CURRENT = 9.7 AMPS				
SHOT LENGTH: 1 SECOND				
INSERTION RESISTOR: NO				
TRIGGER: INTERNAL				

Thermal printout of graphic test results





## Instruments designed and developed by the hearts and minds of utility electricians around the world.

Founded in 1991 and located in Ontario, California, USA, Vanguard Instruments™ offers a wide range of diagnostic test equipment that accurately and efficiently measures the health of critical substation equipment, such as transformers, circuit breakers, and protective relays.

Our first product was a computerized, extra high voltage (EHV) circuit breaker analyzer, which became the forerunner of an entire line of EHV circuit breaker test equipment. Over the years, our portfolio has grown tremendously to include microcomputer-based precision micro-ohmmeters; single- and three-phase transformer winding turns-ratio testers; transformer winding-resistance meters; mega-ohm resistance meters; and a variety of other application-specific products.

Our instruments are rugged, reliable, accurate, and user friendly. They eliminate tedious and time-consuming operations, while providing fast, complex test-result calculations. Using our equipment helps reduce errors and eliminates the need to memorize long sequences of procedural steps.

In 2017, Vanguard Instruments became a part of Doble Engineering Company, an energy industry leader in hardware, software, and services that diagnose and monitor the health of critical assets.



**Vanguard Instruments**

A DOBLE COMPANY

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